PROXIMITY EFFECT CORRECTED PHASE HOLOGRAMS IN PMMA

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ABSTRACT

Computer generated phase holograms (CGPH's) have been fabricated by E-Beam lithography in PMMA using patterned exposure and subsequent partial development. The proximity effect, which if left uncompensated would cause severe performance degradation, is treated exactly by deconvolving the E-Beam dose deposition function (DDF) from the pattern data. The dose deposition function was experimentally determined using samples (1. 8 μm PMMA films on BK7 glass substrates) and E-Beam conditions *(50* KV, *3* nA) identical to those employed in fabrication of the CGPH's. For this purpose, simple edge-step patterns were exposed over a range of intensities. The resultant profiles were measured by atomic force microscopy. A single gaussian plus a delta function sufficed to describe that data. The radius and amplitude of the gaussian component were 0.51 ±.02 and 0,23 ±.02. A Fresnel lens was chosen as a test pattern. It was digitized in 1 μm pixels as a 4K by 4K array of etch depths, modulo $\lambda/(n-1)$ where λ is the wavelength of the helium neon laser and n is the refractive index of PMMA. The data was converted to E-Beam primary dose values using the measured dose vs. PMMA etch depth curve. This dose response curve was determined, like the DDF, under standardized conditions. Etch depth in broad areas could be controled to $\pm\lambda/60$. An efficient, real-valued row, complex valued column 2D FFT algorithm was developed on a DEC VAXstation 3100 that deconvolved the DDF from this pattern. The resultant data array was cropped to 3001x3001 pixels to avoid wraparound errors. Exposures were grouped in 64 bins, and the corresponding shot-rank/dose table was generated. In order to avoid 'negative dose', the entire lens had to be recessed 0.21pm. The lens had a measured optical efficiency of more than 85% and produced a diffraction-limited focal spot. Optical performance data and SEM, AFM, and optical micro graphs will be presented for this lens and for the hologram of a simple image.